Overcoming interoperability challenges of crop area reported by farmer declarations, agricultural census, and Copernicus Earth Observation

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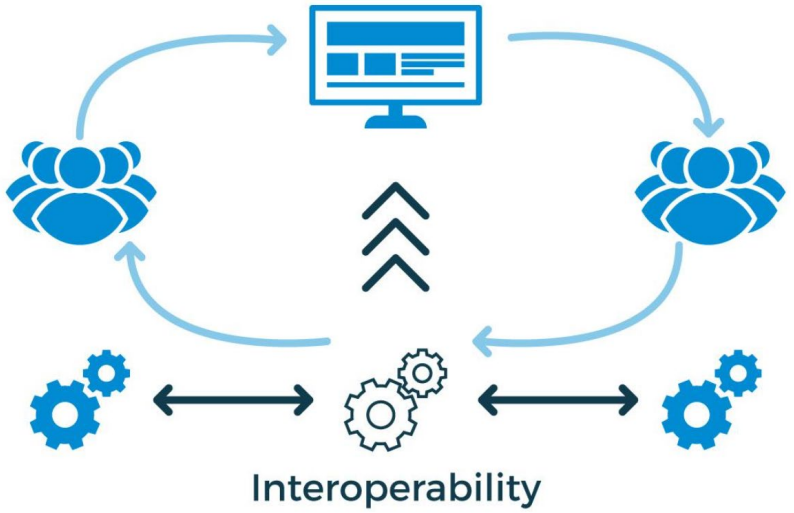
European Commission

Prerequisites for interoperability

- Is the data compatible?
- Is the data comparable?
- Is the data shared?

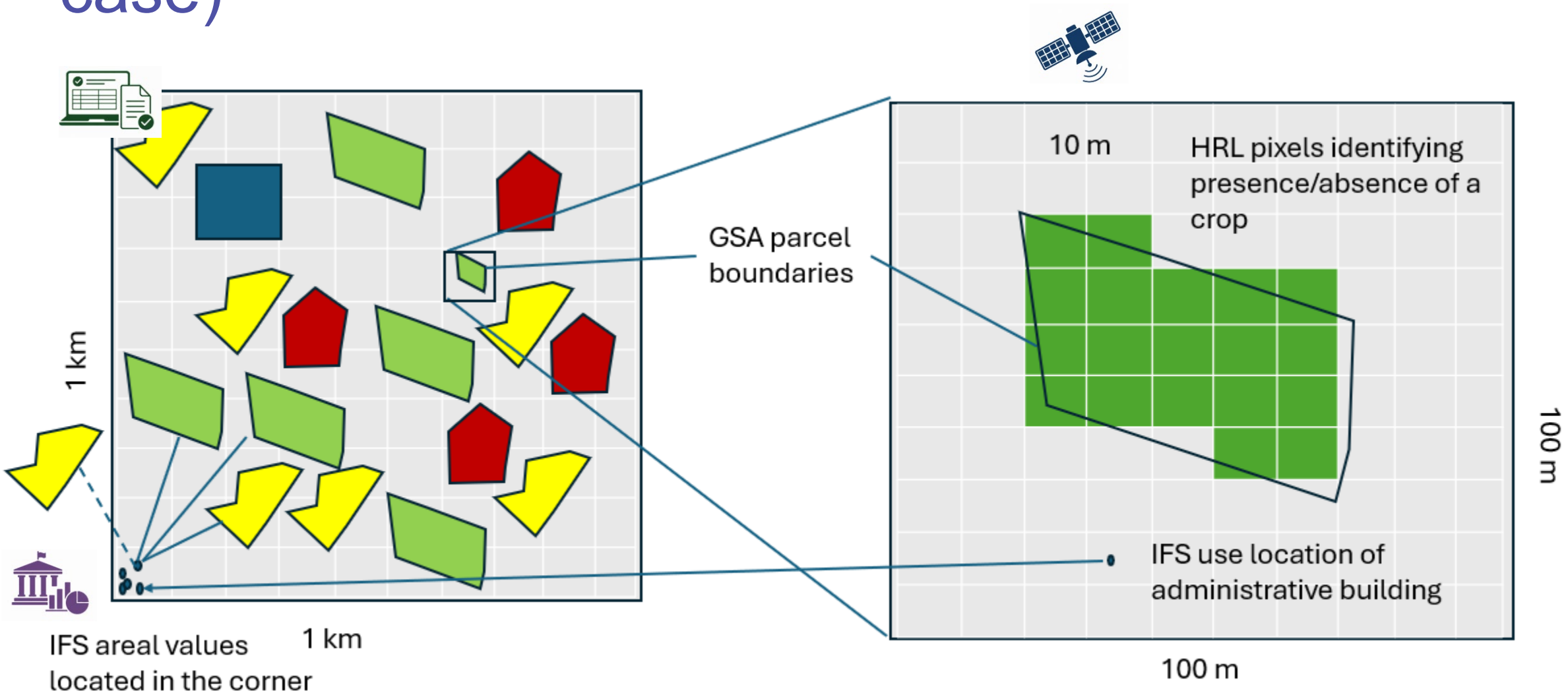
- Agricultural crop area data as example
- Different sources of data used for cross-verifications (EO vs others)
  - Do they measure the same concepts? (semantic)
  - Do they measure the same way?
  - Do they include the same data?



Many sources of data

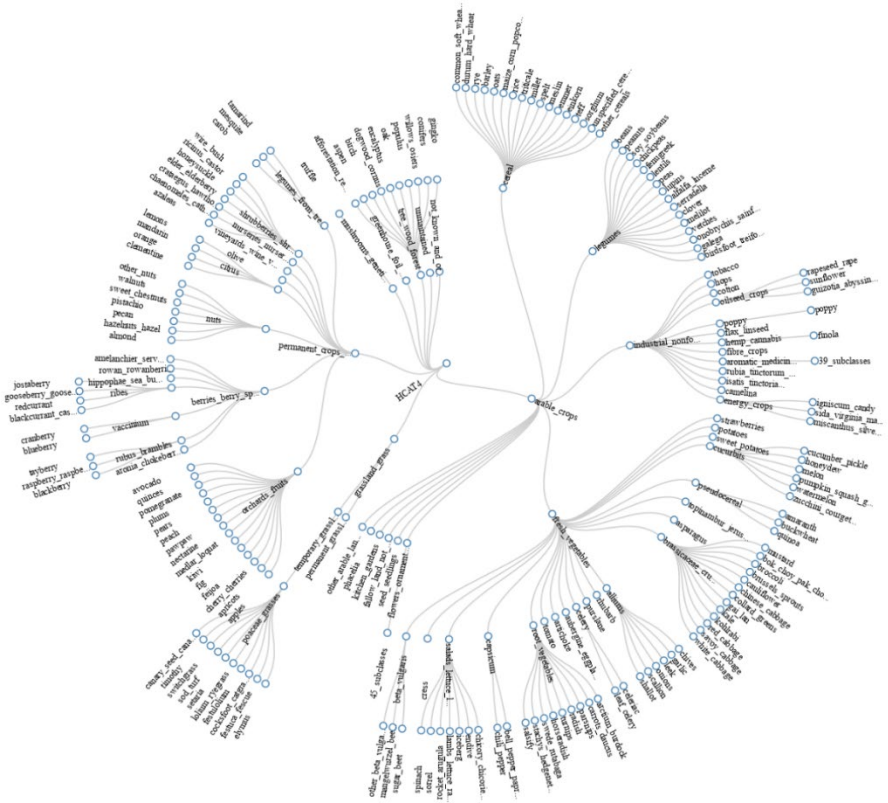
Data type		Coverage	Variables	Precision	Accessibility
Farmers' declarations GSA/IACS		Almost complete	Some	High (but missing non-subsidized crops, and errors / confusion from naming inconsistencies)	Still restricted for many countries
Census data IFS		Almost complete	More	High (but missing farms and crop land below threshold, and more prone to errors if complicated)	Only aggregates accessible (NUTS regions or grids)
Survey data FADN/LUCAS		Samples	Many	Lower (statistical variability in addition to the ones above)	Only aggregates accessible (NUTS regions, sometimes grids)
Remote sensing HRL		Complete	Some	Lower (classification errors)	High resolution

Spatial properties of agricultural crop area (ideal case)



1st step: Comparing apples with apples

- Inconsistent definitions
  - GSA: Different terminology in different countries (including spelling errors)
  - FSS/Eurostat: Sometimes same crops – different usages – different categories – or crops merged in different superior categories
  - EO: Different crops can have similar footprints
- Hierarchical Crop and Agriculture Taxonomy version 4 (HCAT4) for crop classifiction
  - Mapping between HCAT4 classification and taxonomies used in LUCAS, IFS, FADN and national agencies

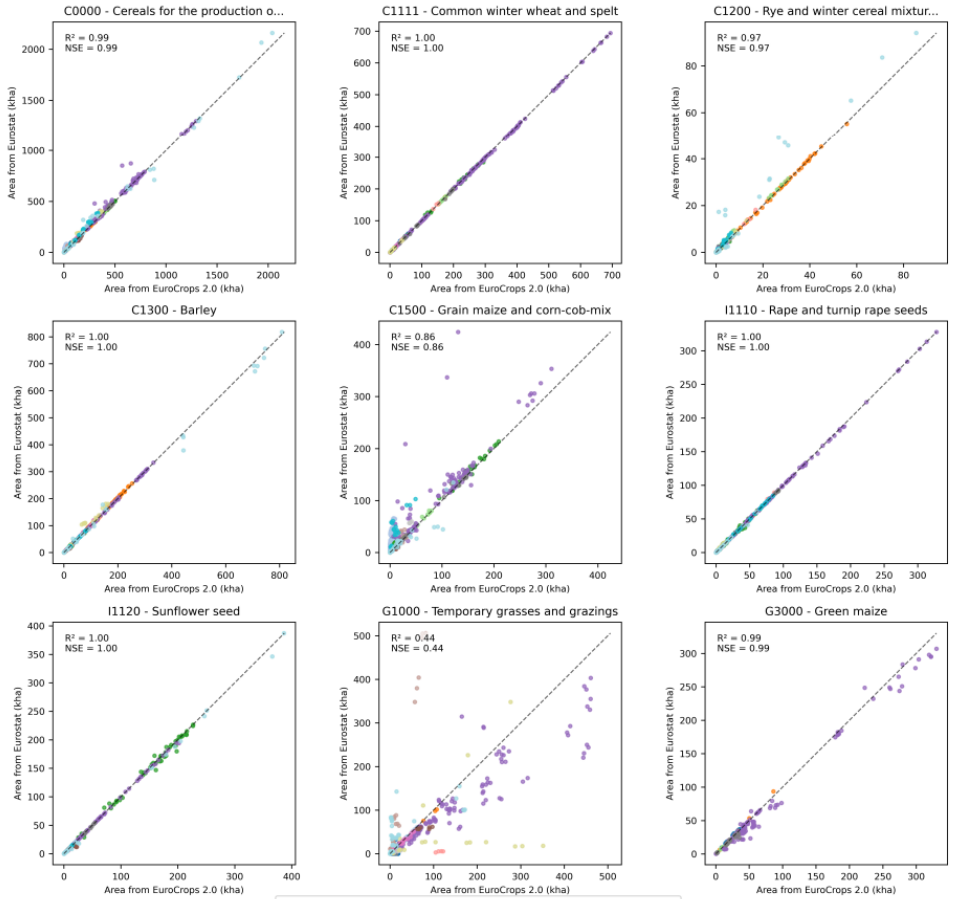


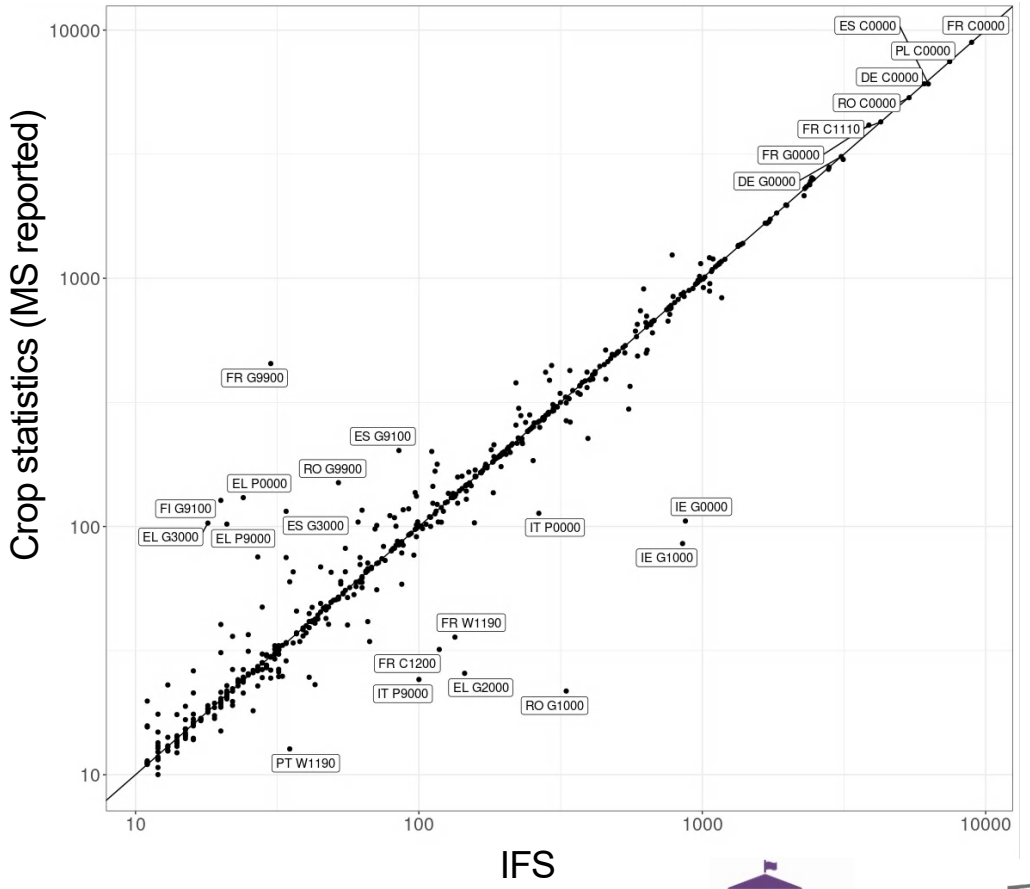
GSA (EuroCrops) vs crop statistics (Eurostat)

Comparison NUTS 2

(Two different data sets for crop statistics from Eurostat)

Crop statistics (MS reported)





IACS/GSA

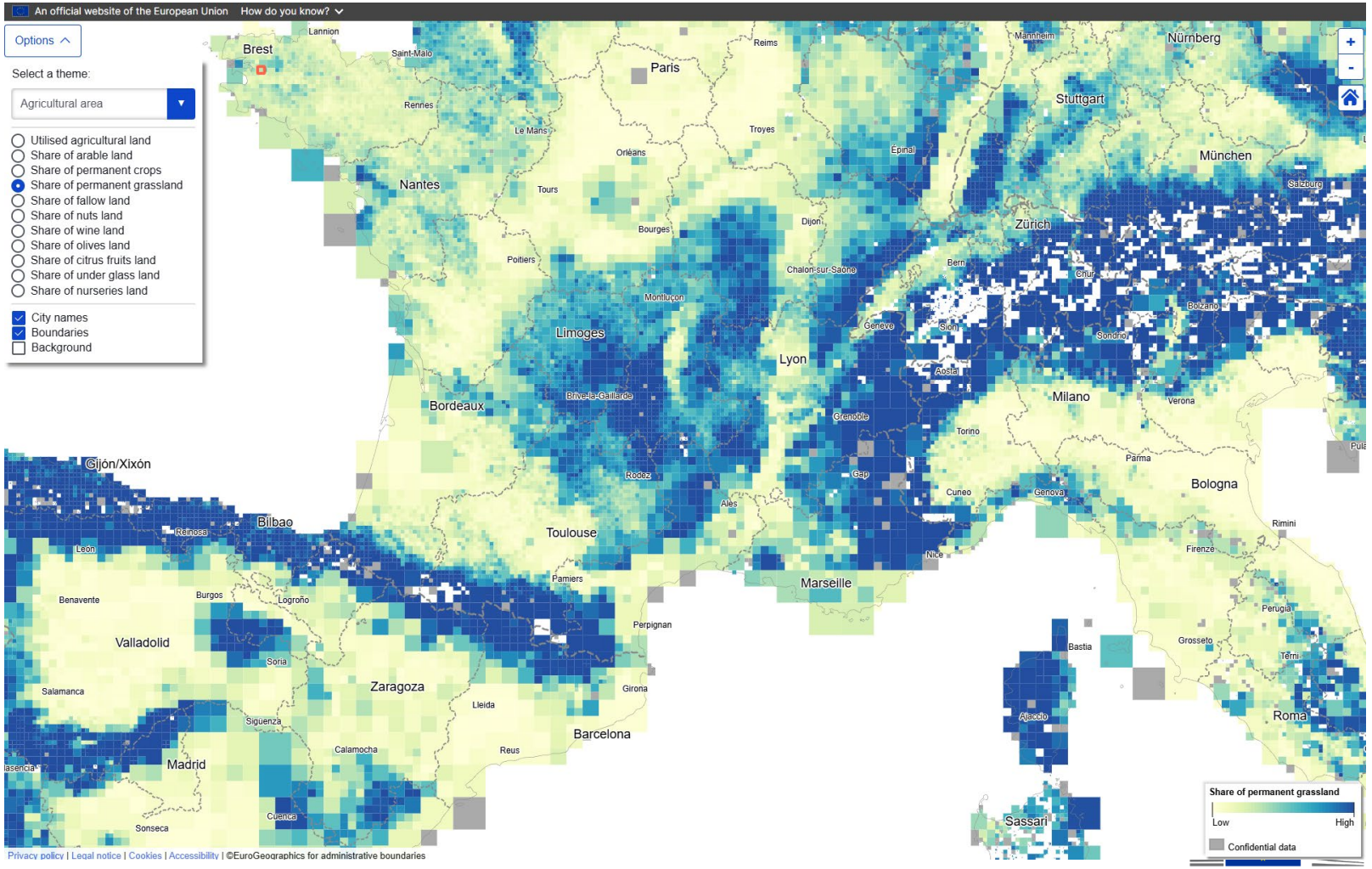
IFS also as gridded data

- Multi-resolution grid
- Respecting confidentiality rules (at least 10 farms, …)
- High resolution with many farms, lower with few farms
- Better for some applications
- 43 layers available:

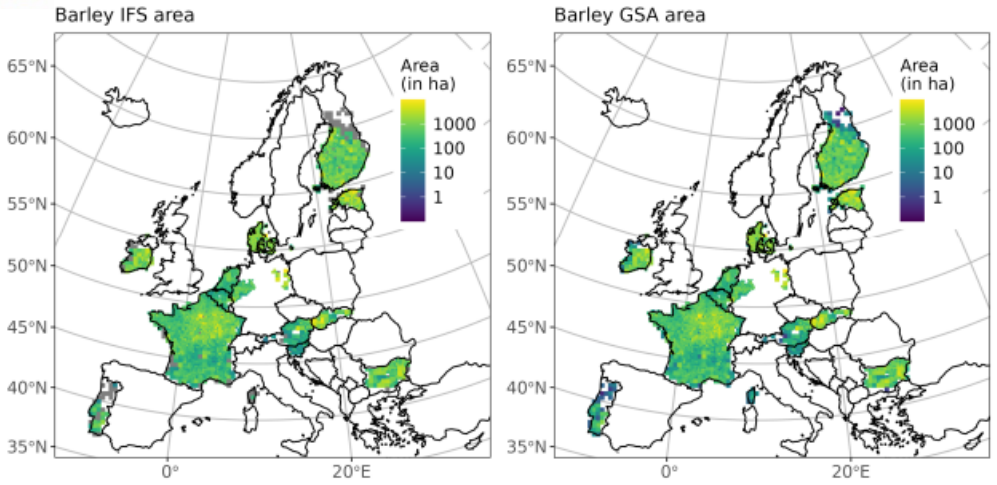
https://ec.europa.eu/eurostat/web/experimental-statistics/geospatial-data-agricultural-census

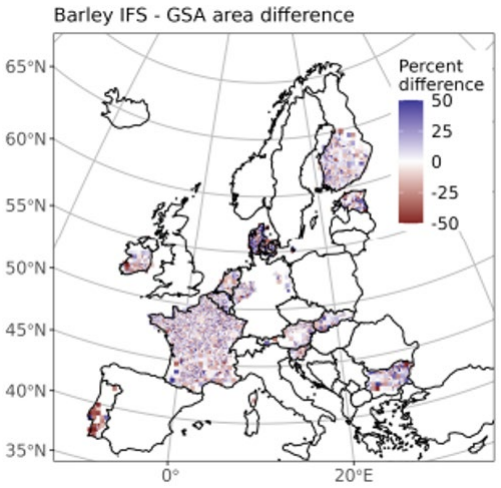
Lampach et al. 2025 Statistical atlas of European agriculture: gridded data from the agricultural census 2020 and the spatial distribution of CAP contextual indicators, Earth System Science Data

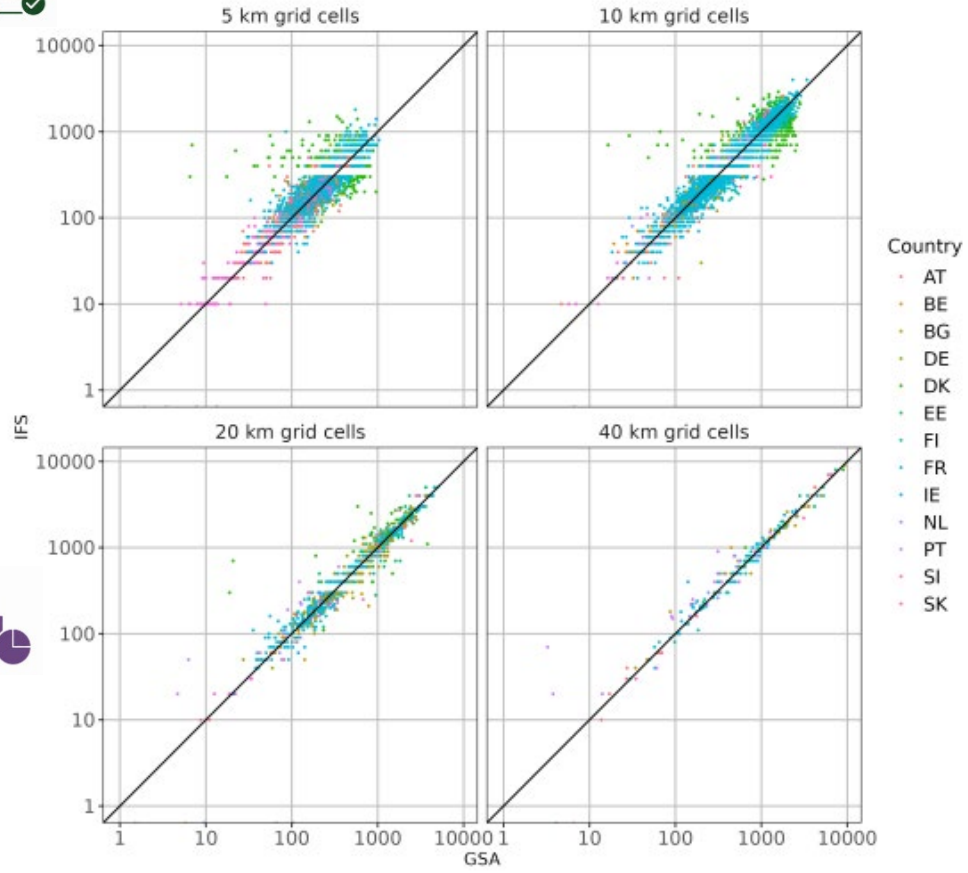
Skøien et al. 2025 A flexible approach for statistical disclosure control in geospatial data, Journal of Geographical Systems



GSA (EuroCrops) vs IFS gridded (Eurostat)



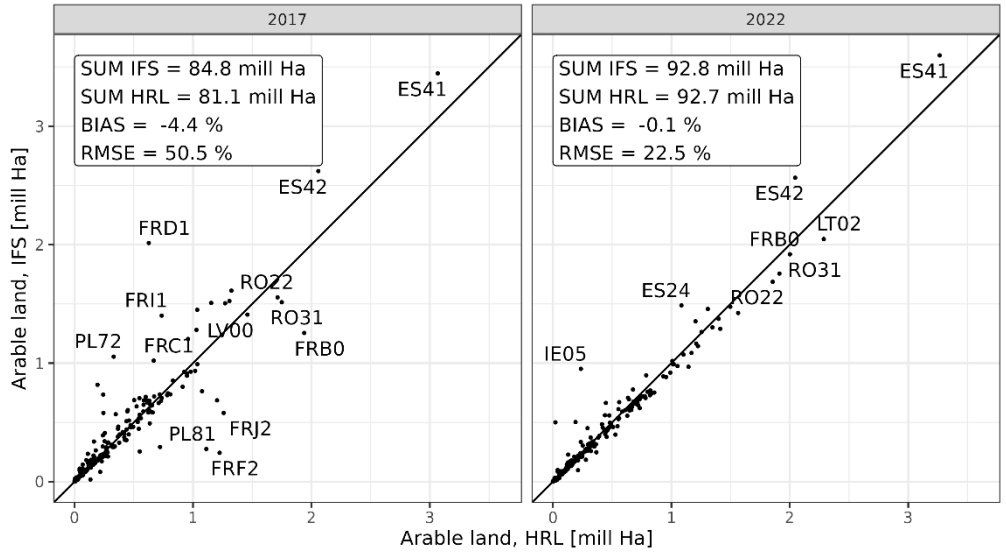


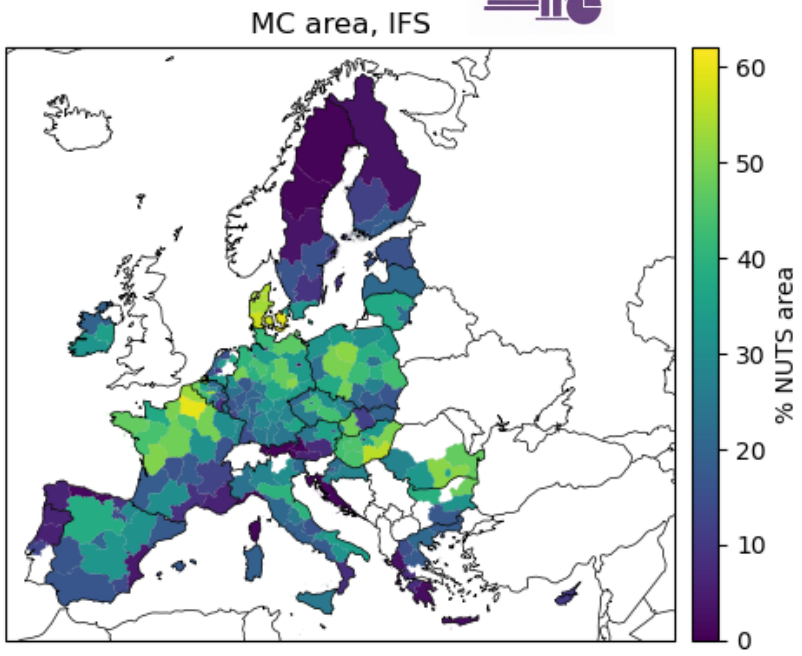


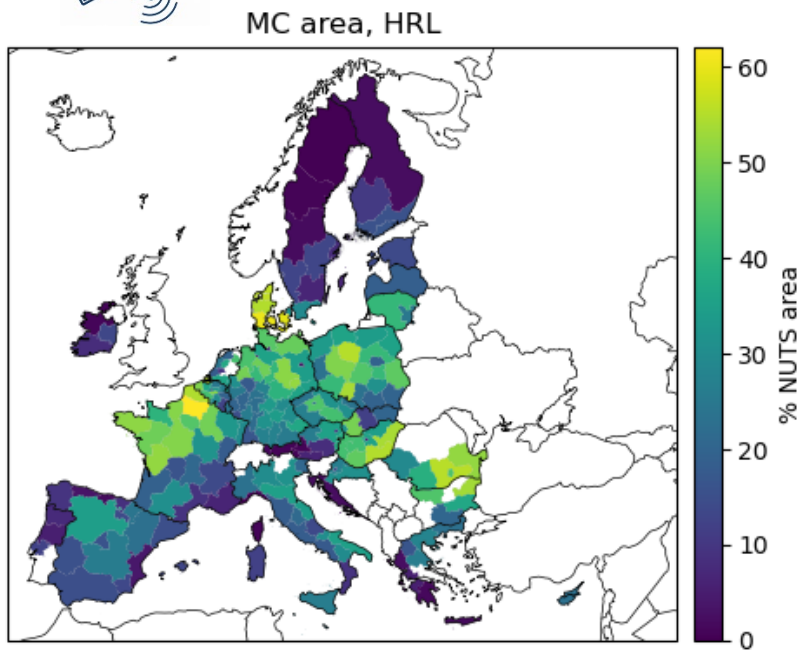
IFS vs EO – arable land

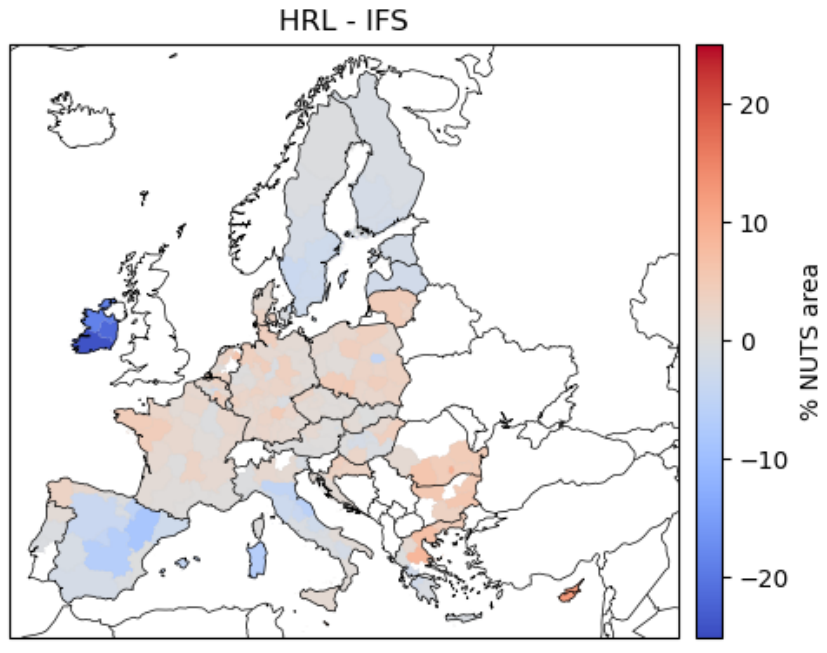
- Initial analyses:
  - Good agreement for 2022 – less 2017

=> Partly because of modified NUTS2 regions





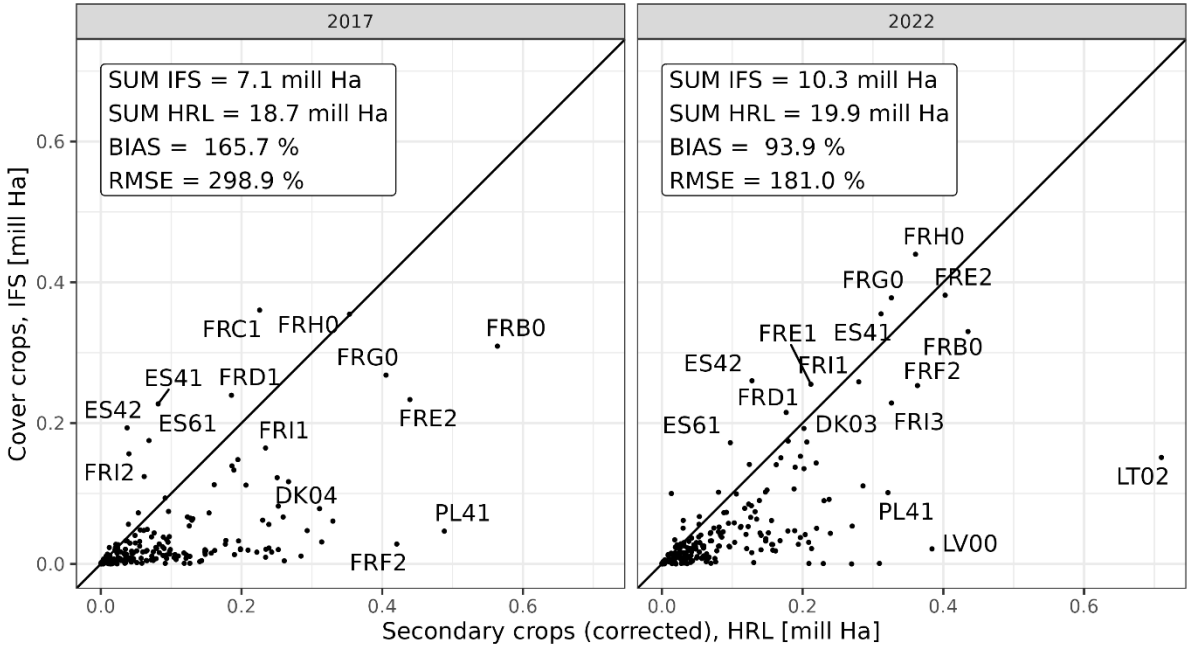


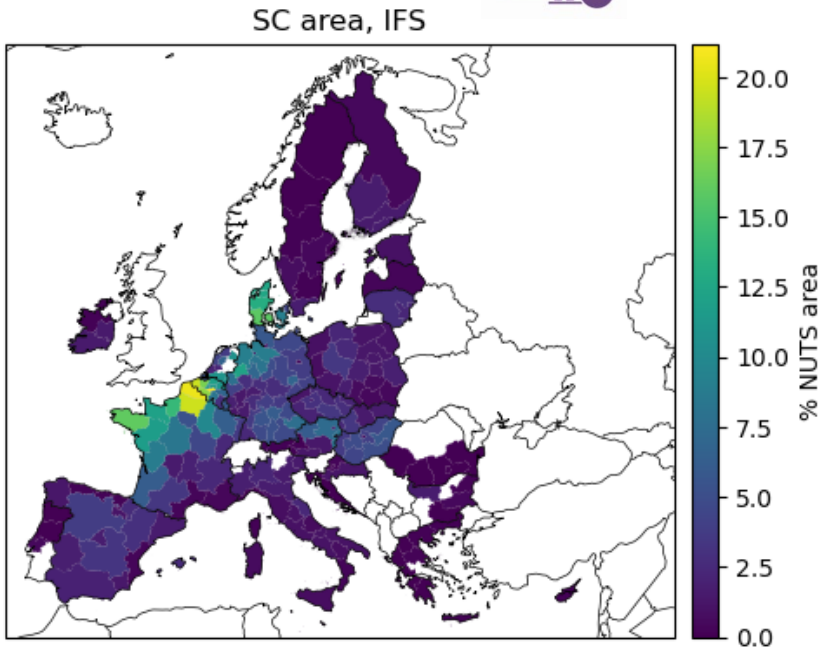


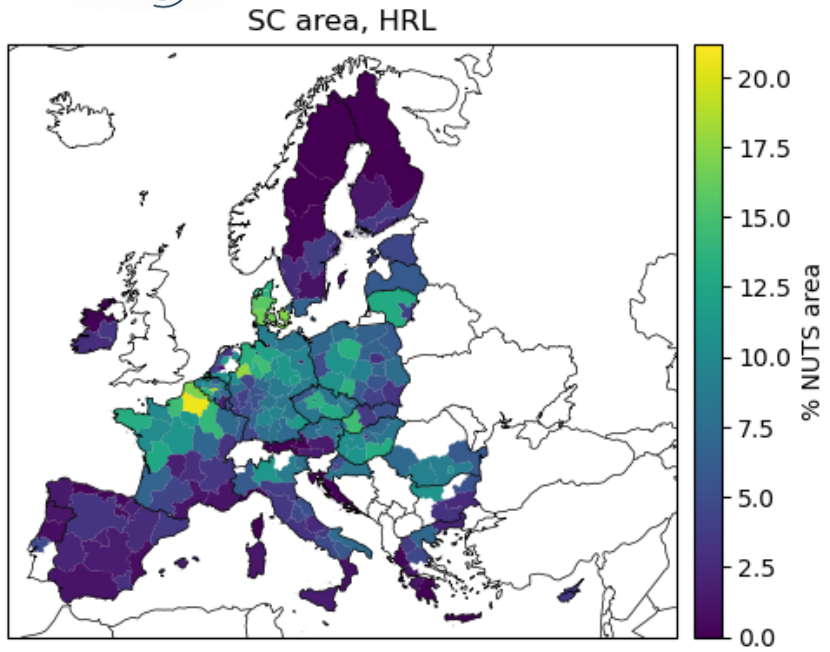
IFS vs EO – Secondary crops

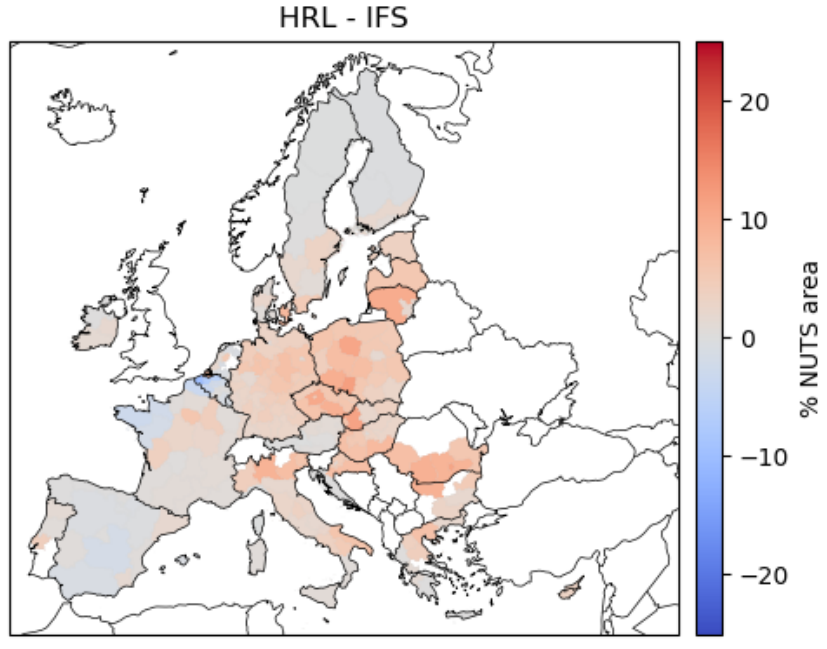
- Also better agreement 2022 than 2017
- Good correlation for countries with large shares of cover crops
  - Belgium, Denmark, NW France, NW Germany, NE Austria
  - Overestimating in Eastern countries + Germany and Northern Italy

- Different definitions – or is HRL detecting crops not classified as SC?





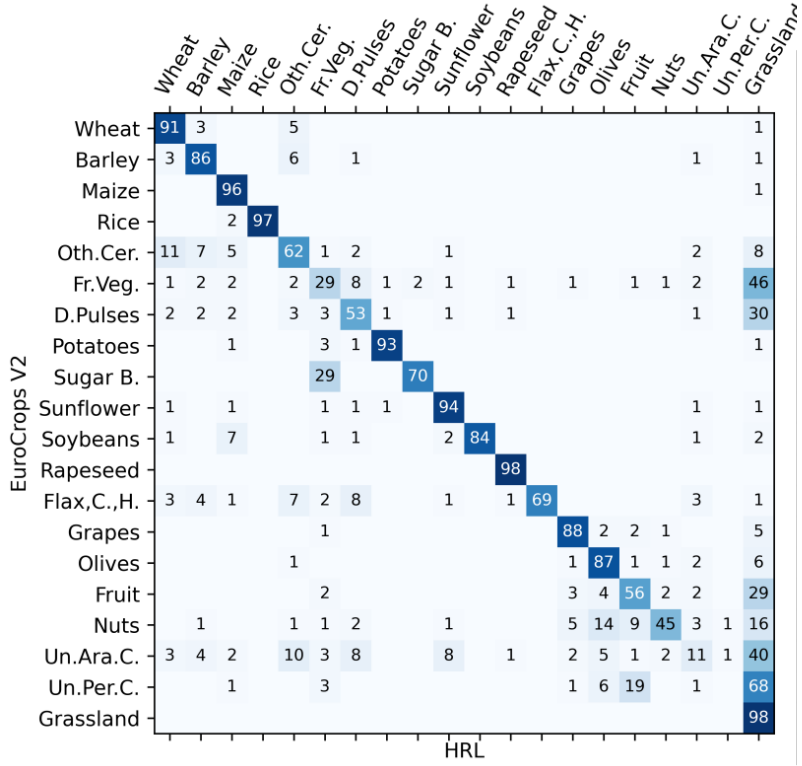




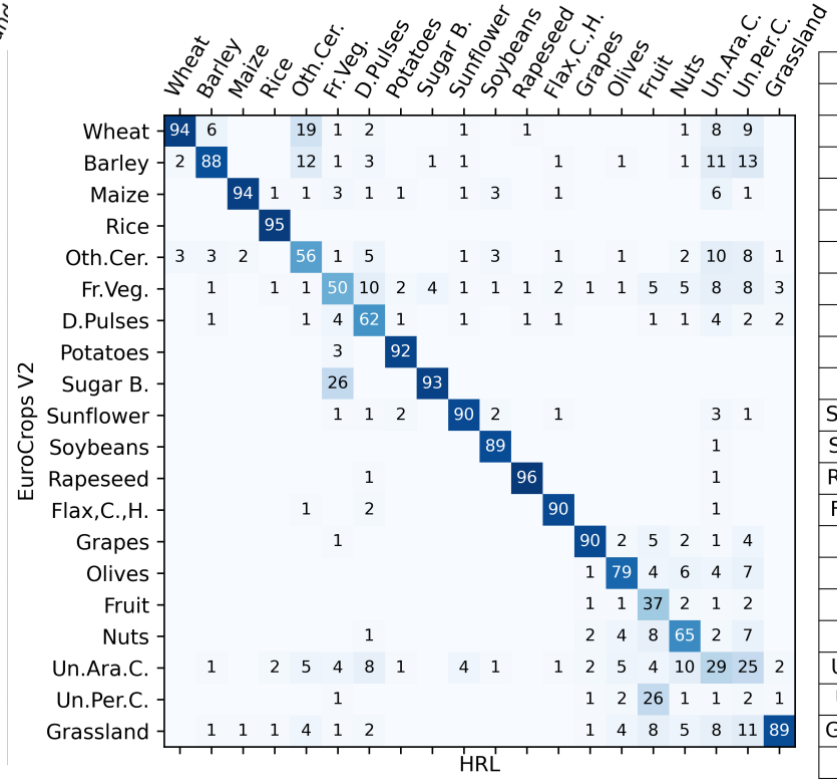
Crop classification – EO (HRL) vs parcels (GSA)

Using pixels fully inside parcel boundaries

Producer's accuracy



User's accuracy

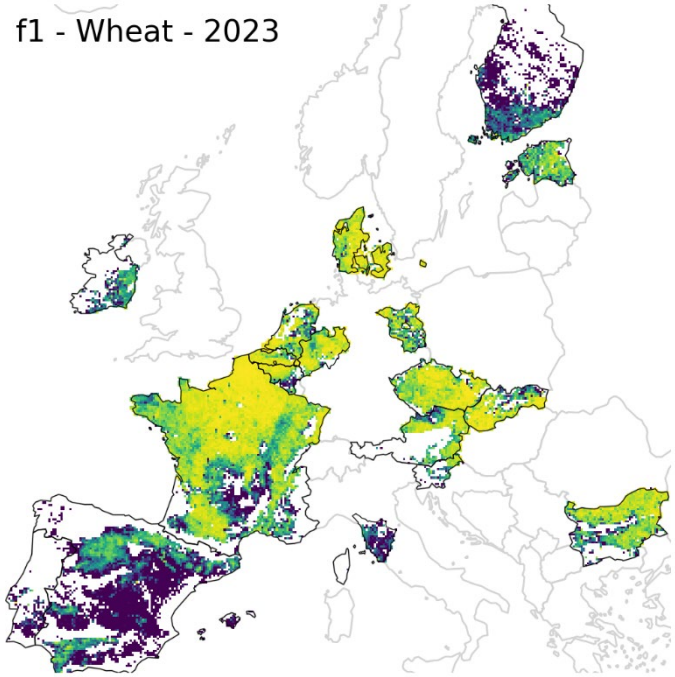


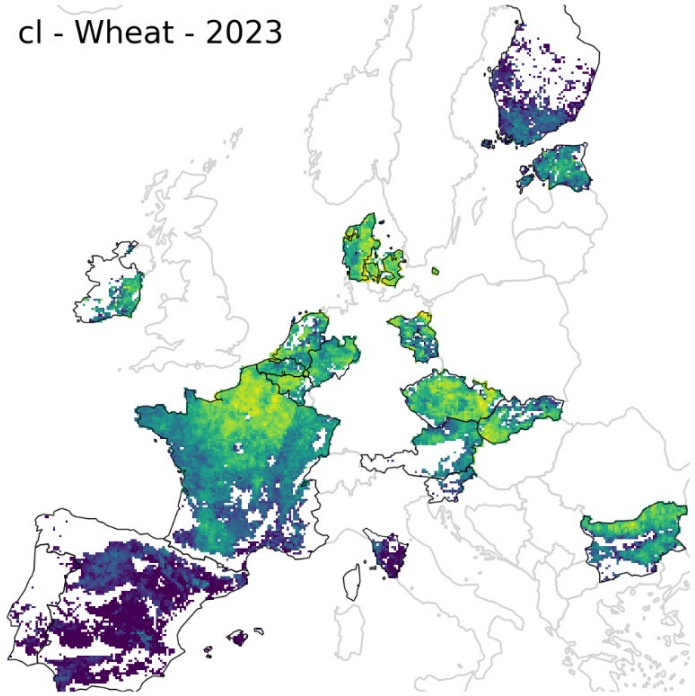
Eurocrops V2 2017-2023

	Over. Acc.	87%
	Area (kha)	F1-score
Wheat	54,000	93%
Barley	26,000	87%
Maize	29,000	95%
Rice	400	96%
Oth.Cer.	12,000	59%
Fr.Veg.	8,000	36%
D.Pulses	7,000	57%
Potatoes	4,000	93%
Sugar B.	4,000	80%
Sunflower	11,000	92%
Soybeans	2,000	87%
Rapeseed	13,000	97%
Flax,C.,H.	1,000	79%
Grapes	5,000	89%
Olives	5,000	83%
Fruit	1,000	44%
Nuts	2,000	53%
Un.Ara.C.	6,000	16%
Un.Per.C.	2,000	0%
Grassland	108,000	93%
	macro-F1	76%

Confidence layer vs accuracy

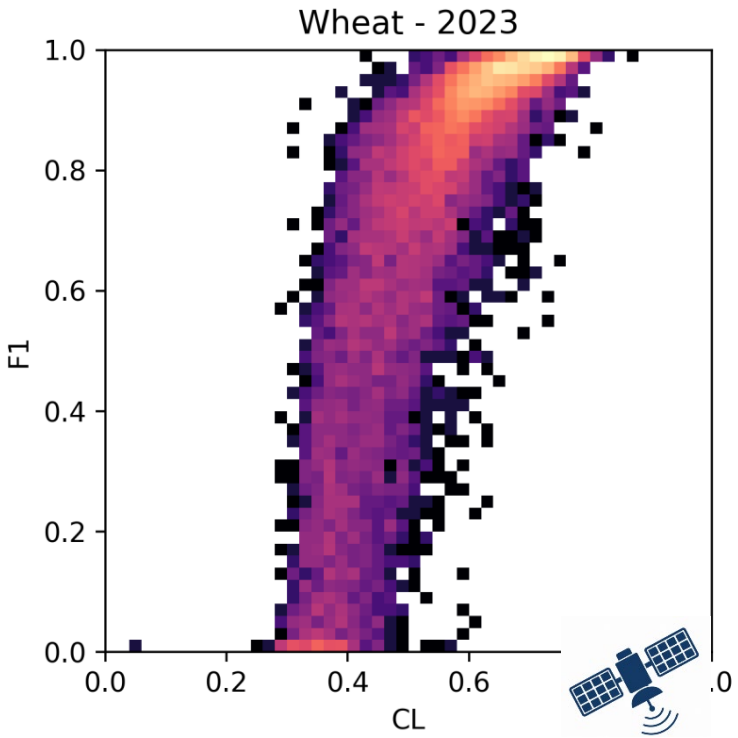
- HRL comes with confidence layer
- Here compared with F1 score - combining precision (true positives) with detection rate (how many positives are identified)
- Within 10 km grid cells





There is a relationship

- Good correlation for high confidence
- More variability for lower confidence



Conclusions - Interoperability is a multidimensional challenge

Semantic differences	Spatial differences	Observation differences
Are we measuring the same concept?	Are we measuring the same place/scale?	Are we measuring in the same way?
• Crop definitions • Taxonomies	• Parcels vs pixels • Comparison areas (NUTS changes) • Grid resolution • Spatial representativity	• EO classification • Reporting behaviour • Survey sampling • Detection limits

- Differences between sources reflect multiple mechanisms, not a single factor
- No single source can serve as a reference without accounting for these differences
- Interoperability requires aligning semantic, spatial and observation dimensions
- Comparisons can help identify potential sources of disagreement (definitions, reporting bias, …)
- Confidence layers can support

Thank you